

**What is claimed is:**

1        1. An apparatus for detection of direct sequence  
2 spread spectrum signals in networking systems, comprising:  
3        a detection unit adapted to take a sample sequence from  
4            a preamble of a newly arrived network packet,  
5            comprising:  
6            a first means for calculating a sequence of  
7                correlation measures between said sample  
8                sequence and a pseudo-noise code sequence of  
9                length  $L$ , where  $L$  is a positive integer;  
10          a second means for calculating an accumulation  
11                sequence in which each accumulation value  
12                thereof is obtained by summing  $N$  correlation  
13                measures that are selected at an interval of  
14                 $L$  from said sequence of correlation  
15                measures, where  $N$  is a predetermined integer  
16                number;  
17          a third means for evaluating a statistic of said  
18                sample sequence over a multiple of  $L$  number  
19                of samples; and  
20          a decision making unit for determining the presence of  
21                direct sequence spread spectrum signals based on  
22                a comparison between said statistic of said  
23                sample sequence and a predetermined threshold  
24                scaled by the maximum of said accumulation  
25                sequence.

1        2. The apparatus as recited in claim 1 wherein said  
2 accumulation sequence comprises  $L$  number of effective

3 accumulation values and said second means calculates said  
4 accumulation sequence,  $\{A_m(N)\}$ , from said correlation measure  
5 sequence,  $\{C(n)\}$ , by the following equation:

$$6 \quad A_m(N) = \sum_{k=0}^{N-1} C(m+k \cdot L), \quad m=0, 1, 2, \dots, L-1$$

7 where  $n$  denotes a time instant,  $m$  denotes an integer index,  
8  $C(n)$  denotes one of said correlation measures at time  
9 instant  $n$ , and  $A_m(N)$  denotes one of said accumulation values  
10 at index  $m$ .

1 3. The apparatus as recited in claim 2 wherein said  
2 decision making unit declares the presence of direct  
3 sequence spread spectrum signals if the following condition  
4 can hold true:

$$5 \quad \frac{\max_m \{A_m(N)\}}{E_r(N)} > 1/\rho$$

6 where  $\max_m \{A_m(N)\}$  denotes the maximum of said accumulation  
7 sequence,  $E_r(N)$  denotes said statistic of said sample  
8 sequence, and  $\rho$  is said predetermined threshold.

1 4. The apparatus as recited in claim 2 wherein said  
2 decision making unit declares the presence of direct  
3 sequence spread spectrum signals if the following condition  
4 can hold true:

$$5 \quad \frac{\max_m \{A_m(N)\}}{E_r(N)} > 1/\rho, \quad N=N_1, N_1+1, \dots, N_2$$

6 where  $N_2 > N_1$ ,  $N_1$  and  $N_2$  are positive integers,  $\max_m \{A_m(N)\}$   
7 denotes the maximum of said accumulation sequence,  $E_r(N)$

8 denotes said statistic of said sample sequence, and  $\rho$  is  
9 said predetermined threshold.

1        5. The apparatus as recited in claim 1 wherein said  
2 third means evaluates said statistic over  $(N-1)$  times  $L$   
3 number of samples of said sample sequence.

1        6. The apparatus as recited in claim 5 wherein said  
2 statistic of said sample sequence,  $E_r(N)$ , is given by:

$$3 \quad E_r(N) = \sum_{n=0}^{(N-1)L-1} |r(n)|^2$$

4 where  $n$  denotes a time instant and  $r(n)$  denotes a sample of  
5 said sample sequence  $\{r(n)\}$  at time instant  $n$ .

1        7. The apparatus as recited in claim 5 wherein said  
2 statistic of said sample sequence,  $E_r(N)$ , can be  
3 approximated by the following equation:

$$4 \quad E_r(N) = \sum_{n=0}^{(N-1)L-1} |r(n)|$$

5 where  $n$  denotes a time instant and  $r(n)$  denotes a sample of  
6 said sample sequence  $\{r(n)\}$  at time instant  $n$ .

1        8. A method for detection of direct sequence spread  
2 spectrum signals in networking systems, comprising the steps  
3 of:

4        taking a sample sequence from a preamble of a newly  
5        arrived network packet;

6        calculating a sequence of correlation measures between  
7        said sample sequence and a pseudo-noise code  
8        sequence of length  $L$ , where  $L$  is a positive  
9        integer;

10 calculating an accumulation sequence in which each  
11 accumulation value thereof is obtained by summing  
12  $N$  correlation measures that are selected at an  
13 interval of  $L$  from said sequence of correlation  
14 measures, where  $N$  is a predetermined integer  
15 number;  
16 evaluating a statistic of said sample sequence over a  
17 multiple of  $L$  number of samples; and  
18 determining the presence of direct sequence spread  
19 spectrum signals based on a comparison between  
20 said statistic of said sample sequence and a  
21 predetermined threshold scaled by the maximum of  
22 said accumulation sequence.

1 9. The method as recited in claim 8 wherein said  
2 accumulation sequence,  $\{A_m(N)\}$ , comprises  $L$  number of  
3 effective accumulation values and is calculated from said  
4 sequence of correlation measures,  $\{C(n)\}$ , by the following  
5 equation:

$$6 \quad A_m(N) = \sum_{k=0}^{N-1} C(m+k \cdot L), \quad m=0, 1, 2, \dots, L-1$$

7 where  $n$  denotes a time instant,  $m$  denotes an integer index,  
8  $C(n)$  denotes one of said correlation measures at time  
9 instant  $n$ , and  $A_m(N)$  denotes one of said accumulation values  
10 at index  $m$ .

1 10. The method as recited in claim 9 wherein said  
2 determining step declares the presence of direct sequence  
3 spread spectrum signals if the following condition can hold  
4 true:

5 
$$\frac{\max_m \{A_m(N)\}}{E_r(N)} > 1/\rho$$

6 where  $\max_m \{A(N)\}$  denotes the maximum of said accumulation  
7 sequence,  $E_r(N)$  denotes said statistic of said sample  
8 sequence, and  $\rho$  is said predetermined threshold.

1 11. The method as recited in claim 9 wherein said  
2 determining step declares the presence of direct sequence  
3 spread spectrum signals if the following condition can hold  
4 true:

5 
$$\frac{\max_m \{A_m(N)\}}{E_r(N)} > 1/\rho, \quad N = N_1, N_1 + 1, \dots, N_2$$

6 where  $N_2 > N_1$ ,  $N_1$  and  $N_2$  are positive integers,  $\max_m \{A(N)\}$   
7 denotes the maximum of said accumulation sequence,  $E_r(N)$   
8 denotes said statistic of said sample sequence, and  $\rho$  is  
9 said predetermined threshold.

1 12. The method as recited in claim 8 wherein said  
2 statistic of said sample sequence is evaluated over  $(N-1)$   
3 times  $L$  number of samples of said sample sequence.

1 13. The method as recited in claim 12 wherein said  
2 statistic of said sample sequence,  $E_r(N)$ , is given by:

3 
$$E_r(N) = \sum_{n=0}^{(N-1)L-1} |r(n)|^2$$

4 where  $n$  denotes a time instant and  $r(n)$  denotes a sample of  
5 said sample sequence  $\{r(n)\}$  at time instant  $n$ .

1        14. The method as recited in claim 12 wherein said  
2 statistic of said sample sequence,  $E_r(N)$ , can be  
3 approximated by the following equation:

$$4 \quad E_r(N) = \sum_{n=0}^{(N-1)L-1} |r(n)|$$

5 where  $n$  denotes a time instant and  $r(n)$  denotes a sample of  
6 said sample sequence  $\{r(n)\}$  at time instant  $n$ .

1        15. A method for detection of direct sequence spread  
2 spectrum signals in networking systems, comprising the steps  
3 of:

4        taking a sample sequence from a preamble of a newly  
5 arrived network packet;

6        calculating a sequence of correlation measures between  
7 said sample sequence and a pseudo-noise code  
8 sequence of length  $L$ , where  $L$  is a positive  
9 integer;

10       calculating an accumulation sequence,  $\{A_m(N)\}$ , from said  
11 sequence of correlation measures,  $\{C(n)\}$ , as  
12 follows:

$$13 \quad A_m(N) = \sum_{k=0}^{N-1} C(m+k \cdot L), \quad m = 0, 1, 2, \dots, L-1$$

14       where

15        $n$  denotes a time instant,

16        $m$  denotes an integer index,

17        $C(n)$  denotes a correlation measure of said  
18 sequence  $\{C(n)\}$  at time instant  $n$ ,

19        $A_m(N)$  denotes an accumulation value of said  
20 sequence  $\{A_m(N)\}$  at index  $m$ , and

21        $N$  is a predetermined integer number;

22 evaluating a statistic of said sample sequence over a  
23 multiple of  $L$  number of samples;  
24 normalizing the maximum of said accumulation sequence  
25 with respect to said statistic of said sample  
26 sequence; and  
27 determining the presence of direct sequence spread  
28 spectrum signals based on a comparison between a  
29 predetermined threshold and said normalized  
30 maximum of said accumulation sequence.

1 16. The method as recited in claim 15 wherein said  
2 normalized maximum of said accumulation sequence,  $NLA_{\max}(N)$ ,  
3 is obtained by:

$$4 \quad NLA_{\max}(N) = \frac{\max_m \{A_m(N)\}}{E_r(N)}$$

5 where  $\max_m \{A_m(N)\}$  denotes the maximum of said accumulation  
6 sequence and  $E_r(N)$  denotes said statistic of said sample  
7 sequence.

1 17. The method as recited in claim 16 wherein said  
2 determining step declares the presence of direct sequence  
3 spread spectrum signals if the following condition can hold  
4 true:

$$5 \quad NLA_{\max}(N) > 1/\rho, \quad N = N_1, N_1 + 1, \dots, N_2$$

6 where  $\rho$  is said predetermined threshold,  $N_2 > N_1$ ,  $N_1$  and  $N_2$   
7 are positive integers.

1        18.The method as recited in claim 15 wherein said  
2        statistic of said sample sequence is evaluated over  $(N-1)$   
3        times  $L$  number of samples of said sample sequence.

1        19.The method as recited in claim 18 wherein said  
2        statistic of said sample sequence,  $E_r(N)$ , is given by:

3        
$$E_r(N) = \sum_{n=0}^{(N-1)L-1} |r(n)|^2$$

4        where  $r(n)$  denotes a sample of said sample sequence  $\{r(n)\}$  at  
5        time instant  $n$ .

1        20.The method as recited in claim 18 wherein said  
2        statistic of said sample sequence,  $E_r(N)$ , can be  
3        approximated by the following equation:

4        
$$E_r(N) = \sum_{n=0}^{(N-1)L-1} |r(n)|$$

5        where  $n$  denotes a time instant and  $r(n)$  denotes a sample of  
6        said sample sequence  $\{r(n)\}$  at time instant  $n$ .